

The Application of Artificial Intelligence to The Determination of Operational Parameters for the Feasibility of a Flight, Algiers Seoul Case Study

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ABSTRACT

Introduction: The aviation industry has always been a highly complex field due to its interdependence, international law, and multiple standards related to passenger safety, aircraft safety, and residential and public works.

Objectives: The main objectives of this study are to determine the flight parameters with one engine failure, namely the load offered and the amount of fuel required for a flight from Algiers to Seoul, and to calculate the distance traveled.

Methods: This study focuses on the application of artificial intelligence to flight feasibility for determining operational parameters, and we will base our studies on compliance with ICAO standards for vertical obstacle clearance. Obstacle clearance, depressurization scenario.

Results: The resulting datasets provide a valuable basis for estimating and determining flight parameters in the event of engine failure, thereby contributing to the development of more robust and effective failure detection systems in the field of flight data analysis. The results highlight a consistent preference for the integration of artificial intelligence in aeronautics.

Conclusions: The application of artificial intelligence in the two critical phases (takeoff and landing) and in the event of engine failure contributes significantly to improving aviation safety and is considered an indispensable tool.

Keywords: artificial Intelligence, Operational Parameters, Drift Down Procedure, flight level, engine failure

INTRODUCTION

During flight, engine failure or pressurization problems are potential issues that must be carefully studied before operating a new route. Their occurrence has a serious impact on flight altitudes and, as a result, becomes very restrictive in mountainous areas (Tapdig et al., 2025; Ian Craig et al., 1998).

In the event of an engine failure during flight, the remaining thrust is no longer sufficient to balance the drag force and maintain an adequate cruising speed (Zhenwei et al., 2024). The thrust required to fly at the initial altitude suddenly becomes greater than the thrust available from the engines operating at their maximum continuous thrust (MCT) (Zhiming et al., 2020). The only solution is then to descend to a more appropriate flight altitude, where the available thrust can equal the required thrust, allowing the aircraft to stabilize. (Hui CHEN et al., 2014).

In the event of cabin depressurization during flight, descent is also necessary. This is not dictated by performance constraints, but by oxygen system constraints. At initial cruising altitude, the oxygen content in the air is insufficient to allow crew members and passengers to breathe normally, (Chenyi et al., 2025). This is why an oxygen system must be installed, (Jessica et al., 2022). Since the amount of

oxygen required must be sufficient to supply the entire cabin, its flow rate is limited to a maximum duration. It is therefore necessary to reach a new flight altitude, where oxygen is no longer needed, within a certain time frame (Premkumar et al., 2019; Xufei et al., 2019).

The descent cannot always be performed under the same conditions, as aircraft sometimes fly over mountainous areas. In these specific cases, a route study is therefore necessary to assess whether an acceptable escape procedure is possible when a failure occurs at the worst possible moment during flight, (Xufei et al., 2023). If it is possible, it must be clearly defined and communicated to the pilots. If it is not possible, a new route must be found (David O'Hare., 2024).

All route studies must be carried out in accordance with the airworthiness requirements detailed in the following sections, (Ian E et al., 2025; Kuznetsov et al., 2013).

Hence our work, which consists of studying the application of artificial intelligence to determine the operational parameters for safe flight, and we have carried out a case study between Algiers and Seoul. The study will focus on regulatory and operational aspects. To determine whether this route is profitable, we will identify the routes to be followed and the procedures to be applied in the event of engine failure or depressurization. The performance of the selected aircraft. This work comprises the following four points:

A study of a drift down procedure in the first part, followed by the different types of obstacles crossing (vertical and in the event of depressurization) in accordance with their conditions and methods. We will also address cabin and engine depressurization failure in the third part, and in the fourth part we will present our results and discussion, concluding our work with a general conclusion.

Drift Down Procedure in case of engine failure:

In the event of engine failure in a mountainous area during climb or cruise, the drift strategy (Figure 1) should be applied. This procedure consists of:

- Select maximum continuous thrust (MCT) on the remaining engine(s).
- Decelerate to green dot speed.
- Ascend or descend at the speed of the green dot until you reach the drift ceiling (drift down).

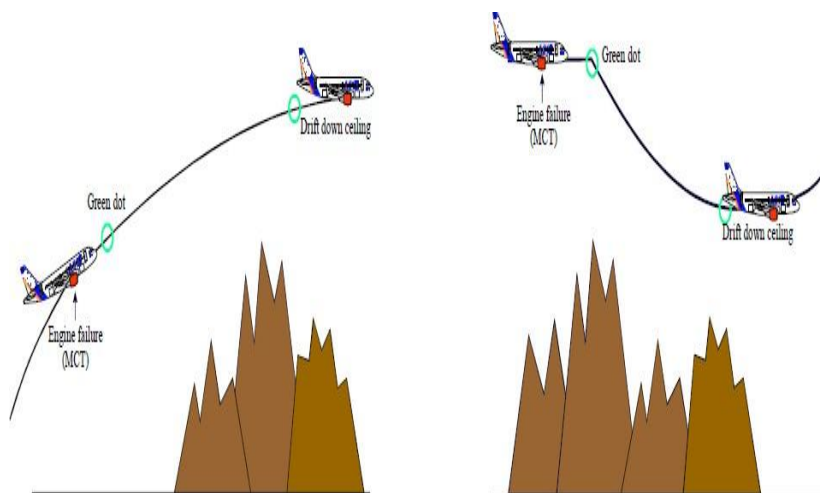


Figure 1. Drift down procedure (ascent and descent)

Green dot speed, indicated by a green circle on the primary flight display (PFD), represents the best speed for lift-to-drag ratio, where aerodynamic efficiency is at its maximum.

Consequently, the drift strategy is the procedure that allows the highest possible altitude to be reached

in relation to the distance traveled.

Table 1. Penalty slope

| | Slope penalty | | |
|---------------------|---------------|-------------|-------------|
| | twin-engine | trimotor | four-engine |
| (n-1) engine | 1.1% | 1.4% | 1.6% |
| (n-2) engine | | 0.3% | 0.5% |

Clearing obstacles:

Obstacles located within a minimum corridor of 5 NM on either side of the planned route.

10 NM if navigation accuracy is not maintained at 95%.

Vertical obstacle clearance:

Condition 1: (1000 ft margin)

This rule allows us to fly over the obstacle vertically with a margin of 1000 ft.

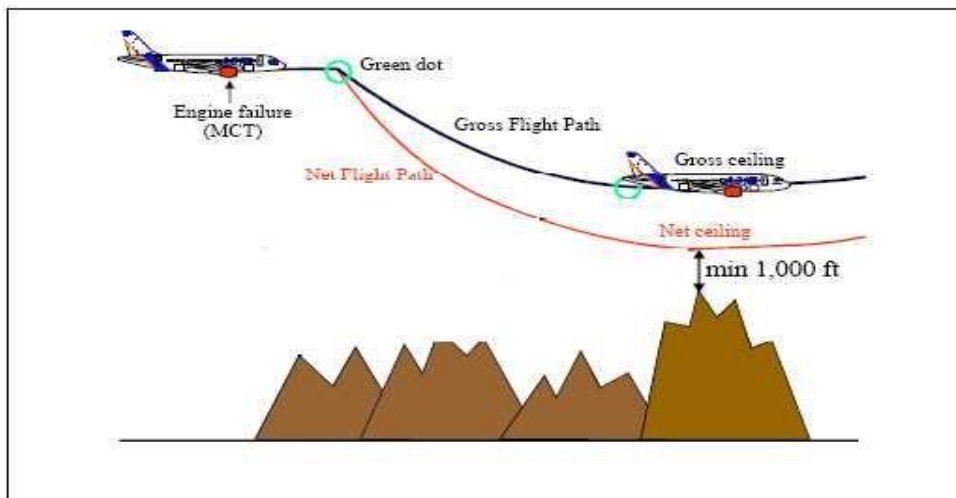


Figure.2. Franchissement vertical des obstacles (marge 1 000 ft)

Method used: (standard rule)

Using a topographical map, determine the most challenging obstacle in the corridor and add 1,000 ft to obtain height H1.

Determine the net descent ceiling called H2 with a constant mass, for example, choose the most penalizing (highest) aircraft mass when the aircraft enters the mountainous area.

Condition 2: (2000 ft margin)

This rule allows us to fly over the obstacle with a margin of 2000 ft, but with a descent.

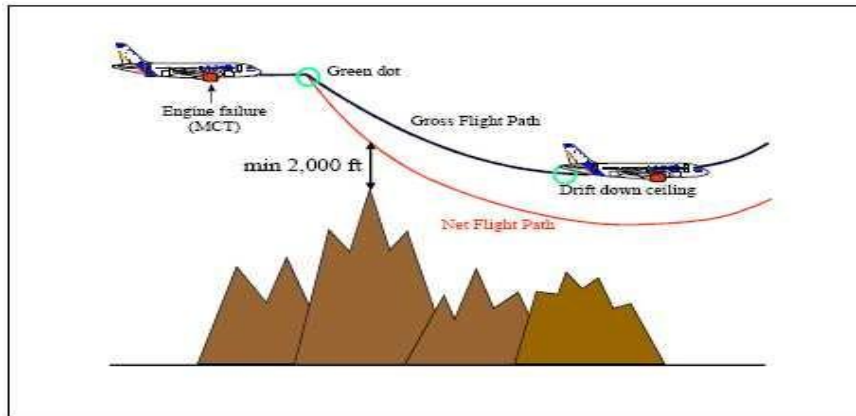


Figure 3. Downhill obstacle clearance (margin 2,000 ft)

In this case, the CDB may apply one of the following three procedures:

- Make a U-turn.
- Take a detour.
- Continue on its way.

The method used: (Down Hill Rule)

Identify the critical point (A) on the route: this is the point at which, if an engine failure occurs, the net trajectory must clear the most severe obstacle with a margin of at least 2,000 ft.

The aircraft's weight at the critical point is the highest that can be assumed at this point in the most penalizing weather conditions. This point may be:

Point of no return (PNR) A: This is the point beyond which it is impossible to turn back, otherwise the 2,000 ft margin of the net trajectory will not be respected.

Continuity point B:

This is the point beyond which it is possible to continue on the route, as the 2,000 ft margin is respected. Identify all the obstacles in the corridor that will be flying over them during the descent, and superimpose these obstacles on the graph, with distance on the horizontal axis and height on the vertical axis.

Determine the net return trajectory (taking into account the altitude and time lost during the return), and the net trajectory to continue the route, taking into account unfavorable wind conditions. For the weight, use the instantaneous weight (at the time of the failure).

Overlay the clear airways on the previous graph, as well as the penalizing obstacles, and verify that the clear airway clears the obstacle with a margin of at least 2000 ft.

METHODS

a) Slow depressurization:

It is characterized by a decrease in cabin pressure, resulting in a continuous cabin climb rate (V_{zc}), which can be high, for example +1000 ft/min.

The detection of an abnormally high cabin vario may initially be physiological in the ears (sensation of ear pain) In the case of very slow depressurization ($V_{ie} = +200$ to $+300$ ft/min), only regular system scanning (e.g., every 30 minutes during cruise or at each turning point) will allow an anomaly to be detected early enough, before excessive cabin altitudes are reached.

For example, an aircraft flying at FL 390 with a $p_{max} = 8$ PSI has a cruising cabin altitude $Z_c = 8000$ ft. A cabin vario of $+1000$ ft/min gives the crew 2 min before the alarms at 10,000 ft cabin altitude and 6 min before the oxygen masks drop.

Following detection, an announcement of “pressurization trouble” allows the crew to focus on a single course of action. The captain then decides how to divide up the tasks: who is in charge of the flight path (piloting and telecommunications) and who handles the incident.

B) Rapid or explosive depressurization:

Rapid decompression results in a very high cabin pressure drop, leaving the crew little time to react before the excessive cabin altitude alarm sounds.

Explosive decompression is a sudden and immediate decompression following structural damage (loss of a window, opening of a door, fuselage crack, explosion on board, etc.). It is characterized by:

- The sound of a loud explosion;
- Fog in the cabin (suspended dust, water vapor);
- A feeling of intense cold;
- Pain in the ears and eyes.

c) flight profile:

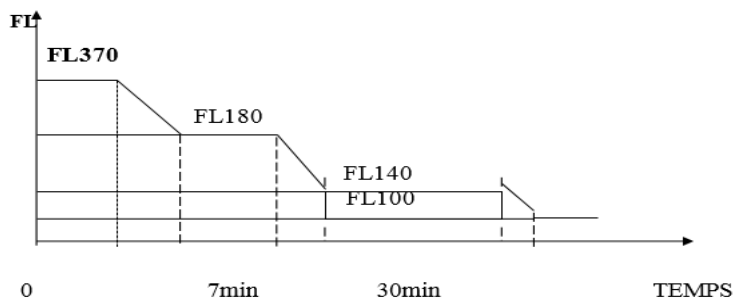


Figure 4. Descent profile (A330-system 22 min)

Following cabin depressurization, the pressure altitude must be considered to be identical to that of the aircraft. Consequently, it is possible to establish a flight profile for the aircraft that takes oxygen requirements into account.

This profile depends on the oxygen system installed:

- Chemical system: this is a fixed profile published in the (FCOM for AIRBUS), (FPPM for BOEING);
- Gas system depends on the number of oxygen cylinders and the location of obstacles. This profile represents the maximum level that can be followed while respecting the capacity of the oxygen system.

Obstacle clearance, depressurization:

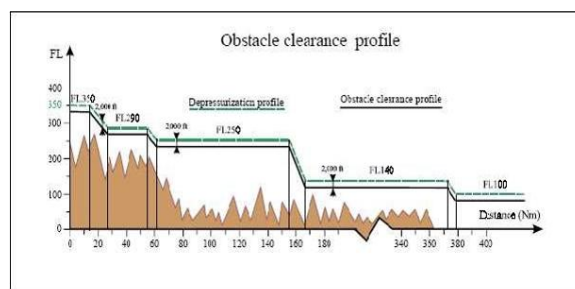


Figure 5. Obstacle crossing, depressurization scenario

The clear path is not required in the event of cabin depressurization; the clear path must be considered a safety margin when there is a risk that the aircraft may not be able to maintain descent performance. In the event of cabin depressurization, the descent profile must clear any obstacle by a margin of 2,000 ft.

Oxygen systems:

The two main oxygen systems that exist are:

The chemical system:

The chemical system is characterized by:

- Independent generator, which activates when oxygen masks are pulled down.
 - Oxygen flow rate and supply pressure that are independent of cabin altitude.
 - Oxygen supply to passengers for a specific period of time, which can be 15 or 22 minutes.
- A maximum flight profile that is predetermined by such a system.

Table 2. Oxygen supply requirements for passengers The gas system

| | | |
|--|---------------------------|---|
| Flight altitude | >15 000 ft | Supply to 100% of passengers |
| | >14 000 ft ≤ 15 000 ft | Supply to 30% of passengers |
| | >10 000 ft ≤ 14 000 ft | Provided to 10% of passengers (not required during the first 30 minutes) |
| | > 8 000 ft ≤ 10 000 ft | Supply to 2% of passengers after cabin depressurization (provided by portable oxygen) |
| With a minimum of 10 minutes of power supply to 100% of passengers | | |

The gas system has certain advantages over the chemical system:

It is modifiable because the number of high-pressure oxygen cylinders can be selected (more than 14 A 330 cylinders);

- The flow rate and pressure of the oxygen supplied depend on the altitude;
- The flow rate is controlled by a flow rate regulator altimeter on each mask, which allows for optimal oxygen consumption by passengers (at low altitudes, oxygen consumption will be lower);
- The oxygen supply time depends on the flight profile and the number of cylinders installed;

There is no oxygen supply below FL 100.

Simultaneous cabin depressurization and engine failure

As a general rule, you should always expect engine or pressurization failures to occur at the most critical points along the planned route. However, since descent profiles differ, the critical points may differ between the two failure scenarios. It is important to note that regulations do not require performance to be taken into account in order to cope with both failures simultaneously.

When the two failure scenarios are treated separately, the number of critical points and specific escape routes also increases. As a result, complexity can lead to additional workload for flight crews and a subsequent risk of error.

That is why, whenever possible, it is preferable to define the same critical points and escape routes, regardless of the failure. This reduces reaction time and the risk of error. In such cases, the route study should be based on the most penalizing descent profile.

RESULTS AND DISCUSSION

Regulatory fuel quantity

Basic flight planning

Regulations require that flight planning take into account weather conditions and delays that are expected during the flight.

The flight must carry sufficient fuel and oil to ensure safe operation, and a fuel reserve must be carried for contingencies.

At the start of a leg, the minimum regulatory fuel consists of:

- Taxiing
- Load shedding
- En route reserve
- Clearance reserve
- Final reserve

Fuel is calculated based on various flight parameters:

- Loads.
- Flight altitude.
- Distance to be covered.
- Weather conditions.

- **Taxiing (r)**

Quantity of fuel required from the moment the engines are started until the brakes are released for takeoff. It is calculated as a flat rate according to the airport. (However, the crew may need to increase this amount in the event of de-icing).

- **Load shedding (d)**

Quantity of fuel from release of brakes on takeoff until wheels touch down on landing. The crew takes into account all foreseeable conditions (departure and arrival trajectories, climb, cruise, descent, air traffic conditions, weather conditions, aircraft weight, etc.) in its calculation.

- **Road reserve (Rr)**

Quantity of fuel intended to cover unforeseen circumstances en route. It represents 5% of the stage weight reduction.

- **reserve of degagement (Rc)**

Quantity of fuel from the point of throttle application at the destination aerodrome (decision height) until touchdown at the alternate aerodrome, taking into account the conditions expected en route.

- **Final reserve (Rf)**

Flat-rate fuel quantity calculated under the following conditions: 15 minutes waiting time at the planned landing mass at 1,500 ft above the aerodrome. There are two additional quantities that are used if necessary:

- **Additional fuel**

This should allow for a 15-minute hold at 1,500 ft above the aerodrome, under standard conditions and when the flight is operated without an alternate aerodrome at the destination.

- **Extra fuel**

The decision to carry extra fuel should be left to the discretion of the pilot in command.

Determination of minimum fuel

Minimum fuel quantity = taxiing + Load shedding + reserve of degagement + takeoff reserve + final reserve + additional

$$QF_{\text{mini}} = r + d + Rr + Rd + Rf + \text{Add}$$

Table 3. Determination of minimum fuel for outbound and return flights

| Fuel (Kg) | Going | return |
|-----------|-------|--------|
| R | 300 | 300 |
| D | 73968 | 81310 |
| Rr | 3699 | 4066 |
| Rd | 6857 | 4115 |
| Rf | 2400 | 2400 |
| Add | 1200 | 1200 |
| QF mini | 88424 | 93391 |

Determination of the maximum load capacity L/O MAX)

L/O max = EPLD = MMD – regulatory fuel – base mass

Where: MMD = Min (MMSD; MMSA+d; MMSC+QLF; MMD obstacle; MMD track).

Table 4. Determination of the maximum load offered (L/O MAX) for the two “Round Trip” phases

| parameter roads | L/O max(Kg) |
|--------------------|-------------|
| Going | 23970 |
| Return | 21704 |

The difference between the two maximum loads offered for the two phases is justified by the difference in the amount of fuel carried for two “round trip” phases.

Choice of flight level

There are international regulations governing the flight level of aircraft according to their heading: from heading 000 to 179, the aircraft flies at an odd level (FL310, FL330, FL350, FL370, FL390 if the aircraft is RVSM compliant) and vice versa. From 180 to 359, the aircraft flies at an even level (FL320, FL340, FL360, FL380, FL400). However, there are some exceptions: Some countries in Europe do not apply the same regulations. This is the case in France, among others, which applies the following system: from heading 270 to 089, even levels, and from heading 090 to heading 269, odd levels.

For the outbound phase: between FL 310 and FL 390

For the return phase: between FL 300 and FL 400.

CONCLUSION

The aim of this work is to make an air route operational. To achieve this, it was necessary to study all possible contingencies, such as engine failure and pressurization failure, in relation to the performance of the A330-202 aircraft.

A drift down procedure is an aviation safety protocol for multi-engine aircraft which, in the event of engine failure at altitude (above its service ceiling with one engine operating), must descend to an

altitude where the remaining engine(s) can maintain cruise flight. The procedure involves setting maximum power on the remaining engines, maintaining a specific speed, and directing the aircraft to an alternate airport, while taking into account terrain and obstacles.

During the operational study of the “Algiers–Seoul” route, we were able to diagnose and examine the performance of the A330-202 and found that the countries in question have adequate airport facilities for the smooth operation of this flight using this aircraft, whose performance is perfectly suited to this long-haul route. as well as develop all procedures in the event of simultaneous engine failure and pressurization failure in order to design this airline route.

The resulting datasets provide a valuable basis for estimating and determining flight parameters in the event of engine failure, thereby contributing to the development of more robust and effective failure detection systems in the field of flight data analysis. The results highlight a consistent preference for the integration of artificial intelligence in aeronautics.

The application of artificial intelligence in the two critical phases (takeoff and landing) and in the event of engine failure contributes significantly to improving aviation safety and is considered an indispensable tool.

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